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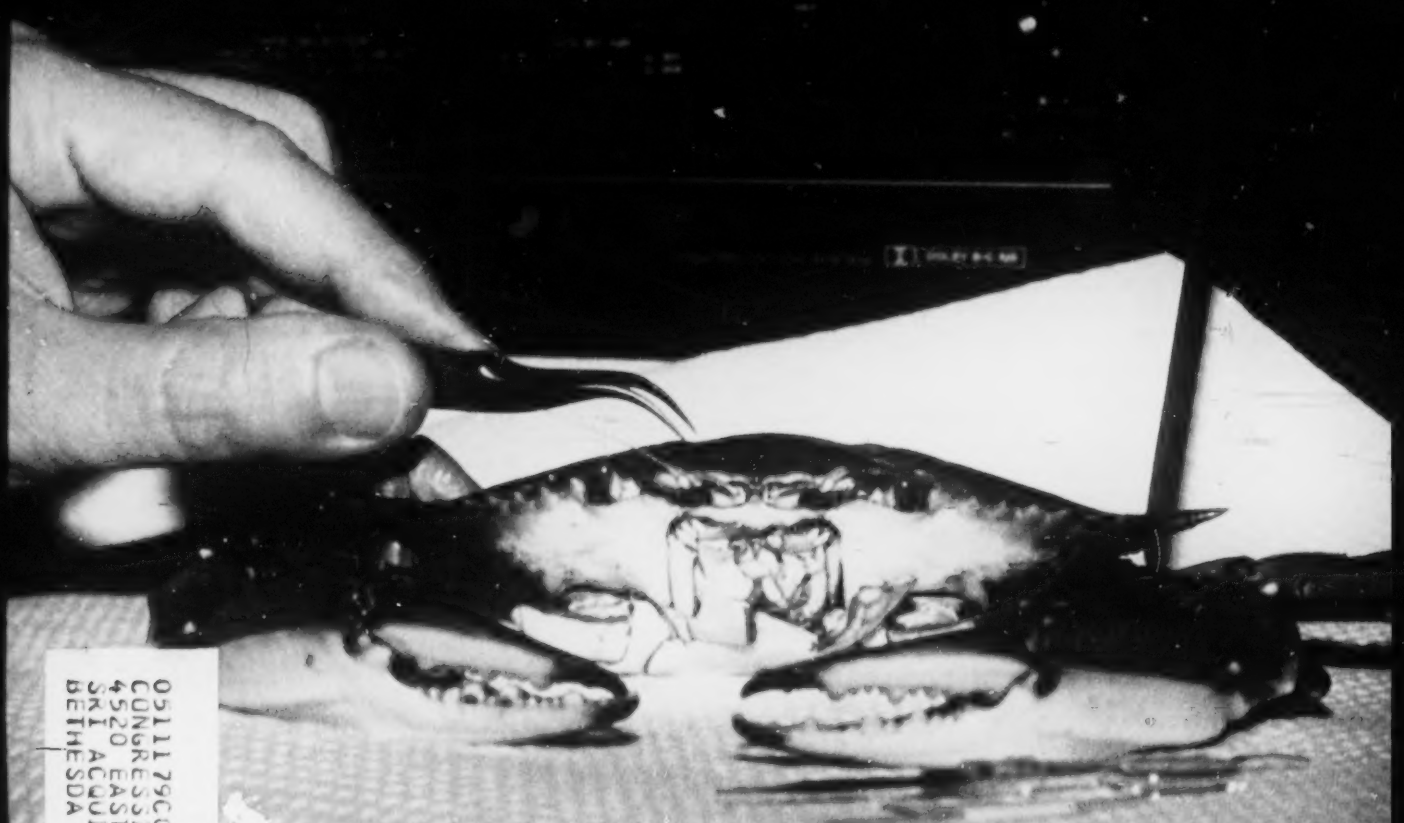
SEPTEMBER 5, 1988

CHEMICAL & ENGINEERING

NEWS



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Biosensors

Using biological components in analytical probes

Page 24

CHEMICAL & ENGINEERING
NEWS
SEPTEMBER 5, 1988

Volume 66, Number 36
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News of the Week

■ **Researchers have recently reported conflicting results on the new thallium cuprate superconductor materials.** **Page 4**

■ **Environmental impact statements have been published on seven sites being considered by the Department of Energy for construction of the Superconducting Super Collider.** **Page 5**

■ **Results from radiocarbon dating of Shroud of Turin are to be released later this month, amidst rumors that some of the data were prematurely leaked to the press.** **Page 5**

■ **Education Secretary William Bennett has suggested a model science curriculum for elementary schools.** **Page 6**

■ **An Italian ship with a cargo of toxic wastes has been denied port entry at a number of countries in Africa and Europe.** **Page 6**

Business

Revenues for biotechnology companies continued to increase markedly in the second quarter, although profits remained elusive for most. **Page 9**

Global market for stampable reinforced thermoplastics will grow 24% annually to reach $1.4 billion in year 2000, according to a Kline & Co. study. **Page 10**

Government

Congress is approving boosts in funding for most research programs in fiscal 1989, with NASA leading the way with a 28% increase. **Page 12**

Education

College chemistry course will be offered via satellite TV to rural high schools under program at Oklahoma State University. **Page 15**

Technology

U.K. government funding cuts in Atomic Energy Authority's nuclear reactor research program lead to diversification moves into nonnuclear research areas such as renewable energy, oil and gas engineering, superconductivity. **Page 19**

Cover: Blue crab is one of several natural sources of chemoreceptors for use in biosensors; the micropipet in front of the crab acts as signal-generating element for such an instrument. Photo by Susan Hallowell

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Special Report

Biosensors—discrete devices that incorporate biological components into a sensor or probe—represent a novel synthesis of biological and analytical concepts. Applications of biosensor technology are emerging in areas such as medicine, biotechnology, food and agriculture, environmental chemistry, and national defense. **Page 24**

Chemical & Engineering News

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LETTERS

Conversion of methane

SIR: The conversion of methane to ethylene is a very worthy but difficult accomplishment. We wish Madan Bhasin and George Keller (C&EN, July 4, page 22) success.

An alternate possible conversion is the dehydration of ethanol to ethylene. At first glance, the alternate conversion appears preposterous—95% ethanol costing from $1.50 to $2.00 per gal and yielding at the most about 0.5 gal of ethylene (measured as a liquid). However, one patent (U.S. 4,423,270, Dec. 27, 1983) and two papers [Kochar, N. K., et al., *Chem. Eng. Prog.* (June 1981), page 66; and Pearson, D. E., et al., *Ind. Eng. Chem. Prod. Res. Dev.*, **20**, 734 (1981)] have been published, which indicate that 70 to 80% aqueous ethanol may be dehydrated to give very clean ethylene, cleaner than from any dehydrogenation process of ethane.

Moreover, reverse osmosis should allow aqueous ethanol to be separated directly from the fermentation liquor, thus bypassing distillation followed by fractionation of the liquor as is practiced by industry. The price of the reverse osmosis product should be much cheaper and raises the following question: Could dehydration of aqueous ethanol compete with dehydrogenative coupling of methane?

Donald E. Pearson
Professor emeritus, Vanderbilt University

Put chemists in charge

SIR: The future of chemistry and the improvement of the economic status of chemists can be assured by putting chemists in charge of things chemical.

An ACS Comment, "Will chemistry exist in the future?" (C&EN, Dec. 14, 1987, page 51) noted the decline in the quantity and quality of students choosing chemistry as a career. John R. Wasson argued for better quality and fewer numbers of chemists as a means to increase their economic benefits (C&EN, March 21, page 5). Edward J. Johnson answered that (C&EN, June 6, page 3) by suggesting that chemists pursue peripheral fields.

Why should we try to control the supply of chemists for the benefit of an elite few? Why should chemists ply their "trade" outside the chemical profession? There is enough to do in the world of chemistry to require an ever-increasing supply of chemists and at the same time increase their economic return.

This is an era in which chemistry is mistrusted by the public, regardless of the great benefits all enjoy because of developments in the field of chemistry. As I wrote in *The Vortex*, the magazine of the California Section, in October 1986, we chemists have brought on the problem with the products we have created, but the problem is not the products; it is their mishandling. And we in the profession have tolerated the mishandling.

Now, we can rectify this and create many jobs for chemists at the same time. We can follow the lead of other professions and insist that any work involving chemicals or chemically dangerous materials be done by chemists or closely supervised by chemists.

Don't just relegate these responsibilities to an environmental manager at headquarters. The large supermarket products warehouse that has stacks of pool chemicals, pesticides, and kitchen, bathroom, and laundry chemicals, should have a chemist supervising those activities, not a warehouse superintendent who can't even pronounce muriatic. Trucks hauling chemical cargoes should be driven by chemists who understand what they are carrying and how it must be handled. Chemists should replace those in industry who haven't been exposed to any knowledge about the chemicals they use since some chemical salesperson introduced them to the product they are using years ago.

Truck drivers, janitors, dock wallopers, foremen, and others can't practice medicine or law. Why should they be allowed to practice chemistry—i.e., make chemical decisions about the use or handling or disposal of the products they are involved with, knowing little or nothing about them?

Sure, this would change our traditional view of chemists. Some might have to join the teamsters union, for instance. But maybe that high school kid who is teetering about becoming a chemist would gladly become one if he or she could also drive an 18-wheeler.

Chemist truck drivers. Chemist railroadmen. Chemist production supervisors. Chemist warehouse supervisors. It boggles the mind to think of the vast numbers of opportunities that would be available for chemists doing these jobs related to chemicals. And don't say the cost to business would be enormous. I'm talking about putting chemists into jobs that traditionally have paid more than many chemists have been paid.

Best of all, gradually, as these chemists took charge of things chemical, there would be a sharp reduction in

Revenues Continue To Grow at Biotechnology Companies

R&D contracts are still major spur to revenues, although product sales are playing an increasing role; very few firms, however, show profits

Revenues for biotechnology companies continue to grow solidly, but most firms still lack any signs of earnings and, in some cases, losses at the companies almost equal their revenues.

The firms' revenues are still being spurred by increasing R&D contracts, but more and more firms are seeing product sales contributing to the monies they take in. For 20 biotechnology firms surveyed by C&EN, second-quarter revenues totaled $179 million, an increase of 44% from the same period last year. Losses for the companies deepened slightly to a total of $15.9 million from about $15.7 million in the second quarter of 1987.

For the first six months, combined revenues for the 20 companies totaled almost $341 million, up 46% from first-half 1987. Losses at the companies added up to $25.1 million, a decrease from losses of more than $37.2 million in the first six months of last year.

Industry observers expect to see losses grow larger at many of the companies before the industry as a whole begins to turn profitable. This is because the companies are funding clinical trials and other research and development endeavors—a large cash drain necessary for their products to receive the government approval required before their products can enter the marketplace. For instance, at Ribi Immunochem, losses for the quarter deepened to $555,682 from $151,206. Robert E. Ivy, president and chief executive officer of the company, says: "The increased loss reflects our planned acceleration in research and development spending."

Of the 20 companies surveyed by C&EN, only four were profitable in the second quarter. These were industry leader Genentech, plus Am-

Revenues were up 44% for 20 biotechnology companies in second quarter

	SECOND-QUARTER 1988						FIRST-HALF 1988					
	Revenues[a]	Earnings[b]	Change from 1987		Profit margin[c]		Revenues[a]	Earnings[b]	Change from 1987		Profit margin[c]	
	($ millions)		Revenues	Earnings	1988	1987	($ millions)		Revenues	Earnings	1988	1987
Amgen	$ 19.447	$ 0.305	55%	−38%	1.6%	3.9%	$ 34.020	$ 0.793	47%	9%	2.3%	3.1%
Applied Bioscience	11.444	0.929	47	28	8.1	9.3	21.875	1.812	48	35	8.3	9.1
Biogen	7.229	−0.866	172	def	def	def	14.046	−1.801	104	def	def	def
Calgene	5.925	−2.009	−10	def	def	7.6	15.088	−1.965	8	def	def	5.8
California Biotechnology	3.320	−3.512	9	def	def	def	7.680	−5.199	26	def	def	def
Cetus	15.972	−9.372	4	def	def	def	32.582	−16.346	12	def	def	def
Cytogen	1.778	−3.486	−25	def	def	def	3.570	−6.611	−27	def	def	def
DNA Plant Technology	1.495	−0.535	−21	def	def	def	3.035	−0.890	−18	def	def	def
Damon Biotech	1.003	−2.065	−23	def	def	def	2.817	−3.616	10	def	def	def
Ecogen	1.075	−1.247	10	def	def	def	3.116	−1.942	88	def	def	def
Genentech	89.586	15.474	89	194	17.3	11.1	163.710	30.685	90	213	18.7	11.4
Genzyme	6.167	0.120	97	50	1.9	2.6	11.464	0.202	36	52	1.8	1.6
Integrated Genetics	4.224	−0.446	53	def	def	def	7.660	−1.370	24	def	def	def
Liposome	1.169	−1.452	33	def	def	def	2.132	−3.276	22	def	def	def
Molecular Genetics	1.237	−1.058	−73	def	def	def	2.649	−1.442	−61	def	def	def
Monoclonal Antibodies	2.283	−0.740	204	def	def	def	4.098	−2.156	78	def	def	def
Repligen	1.793	−1.050	−70	def	def	50.4	3.796	−2.120	−51	def	def	28.2
Ribi Immunochem	0.301	−0.556	−26	def	def	def	0.640	−1.023	−24	def	def	def
Synergen	2.435	−0.606	18	def	def	def	4.183	−1.786	−1	def	def	0.2
Xoma	1.330	−3.763	−10	def	def	def	2.513	−7.063	68	def	def	def
TOTAL	$179.213	$−15.935	44%	def	def	def	$340.674	$−25.114	46%	def	def	def

a Includes sales, contract research, royalty, and interest revenues. b Excludes extraordinary and nonrecurring items where possible. c After-tax income as a percentage of sales. def = deficit.

gen, Applied Bioscience, and Genzyme.

Genentech, with its sales of tissue plasminogen activator and human growth hormone, posted earnings almost triple those in last year's second quarter to about $15.5 million on an 89% gain in revenues to $89.6 million. For the first six months, Genentech's earnings totaled $30.7 million, up 213% from first-half 1987, and revenues rose 90% to $164 million.

At Amgen, earnings fell 38% in the quarter to $305,000, but revenues climbed 55% to $19.4 million. For the first six months, Amgen's earnings rose 9% to $793,000 on a revenue increase of 47% to $34 million.

Applied Bioscience's earnings for the quarter were up 28% to $929,000 on a sales increase of 47% to $11.4 million. For the half, the company's earnings jumped 35% to $1.81 million on a revenue increase of 48% to $21.9 million.

And Genzyme recorded a 50% increase in quarterly earnings to $120,000 on a revenue rise of 97% to $6.17 million. For the first six months, Genzyme's earnings were up 52% to $202,000, and revenues increased 36% to $11.5 million. Genzyme chairman and chief executive officer Henri A. Termeer says, "Our revenue growth remains on track to exceed $25 million in 1988. With the anticipated launch of [the antibiotic] clindamycin later this year, our profitability should also strengthen." Genzyme is also continuing to broaden its glycoprotein remodeling business. It has signed an agreement with Snow Brands Ltd. of Tokyo to market three new Snow Brand glycoprotein remodeling reagents in the U.S.

Some of the companies had increased product sales during the quarter. For instance at Ribi Immunochem, product sales rose 29% in the second quarter to $130,686. Product sales at Monoclonal Antibodies soared 294% to $2.17 million. Thomas Glaze, chief executive officer, attributes recent sales growth to strong demand for the firm's in-home ovulation prediction test.

Industry observers are predicting a difficult time for many biotechnology firms over the next 12 to 18 months. Roger Shamel, president of Consulting Resources Corp., a Lexington, Mass.-based market research firm, says, "Although promising products are on the horizon, and the industry as a whole is showing signs of growth, biotechnology on an individual company basis, remains a risky business." According to Shamel, financing has become more difficult since the stock market crash last year.

On the expense side of the income statement, Shamel says mounting costs relating to scaleup, patents, and regulations seem to be growing much faster than product revenues. On the legal front, patent lawsuits are heating up.

However, despite the problems, a study done at Consulting Resources concludes that biotechnology is moving into a rapid growth phase. Although the flow of products thus far has been only a trickle, the rate of introduction will increase dramatically in the next few years.

William Storck

Stampable plastics use to grow 24% annually

By the end of this century, the worldwide market for stampable reinforced thermoplastic sheet is forecast to grow to about $1.4 billion, a 24% average annual rate over the 1987 level of $80 million, according to market researchers Kline & Co.

Stampable reinforced thermoplastics are high-performance materials adaptable to many semistructural and structural applications. The incorporation of fiber reinforcements yields low-cost, high-performance composites. According to the Passaic, N.J.-based firm, stamping technology has been applied to all thermoplastics from commodities to engineering resins to highly heat-resistant materials.

According to a Kline study, the technology was pioneered in the U.S. by PPG Industries with its Azdel brand polypropylene sheet. Two years ago, PPG formed a joint venture, Azdel Inc., with General Electric to exploit the technology with new base resins for new uses.

The study says that overseas activity has been even greater with four major European suppliers active in thermoplastic composites. These include Shell, BASF, Exxon, and Chemie Linz. Other European companies have programs in developmental stages.

In Japan, two companies have licensed the original PPG technology and others are developing new products internally.

According to Kline, recent market and technological developments are expected to fuel dramatic growth through the year 2000 when worldwide consumption of stampable sheet is expected to reach 1 billion lb. An increased range of applications will result from new resins, higher reinforcement levels, improved processing techniques, and more emphasis on suppliers. Other factors fueling the growth include a varied group of reinforcement types, an expanding range of substrate resins, new production processes being developed, increasing productivity, and the development of class-A finish parts using mineral fillers, varying reinforcements, metal-cladding technology, and complementary processing techniques.

In addition, the study says, more than 18 major organizations worldwide have active research programs in the area. Among these, apart from the PPG-GE joint venture, Akzo and Isosport have a cooperative agreement; Du Pont, Chemie Linz, Eastman Kodak, Himont, and Dow Chemical are developing processes internally; Exxon has acquired technology developed by Japan's Arjomari; and Shell has acquired Symalit, which Kline calls Europe's leading supplier.

Several types of firms are capitalizing on the growth trend. Resin suppliers are using the technology to increase material performance, opening up new uses; fiber reinforcement and mineral suppliers are offering products tailor-made for use in thermoplastic composites; sheet molding compound molders and metal stampers are broadening their business scope and protecting key business areas. And, Kline says, equipment makers must provide customized and fully automated systems to ensure the upward growth.

William Storck

Congress Approving Increases for Most R&D Programs in Fiscal '89

Research funding hikes range from 5% for the Department of Energy to 28% for NASA; in between are increases for NSF, 9%, and EPA, 8%

Janice R. Long, C&EN Washington

Congress is well on its way to accomplishing a feat it hasn't been able to achieve in the past half dozen years or so—enactment of all 13 of the fiscal 1989 appropriation bills before the current fiscal year expires on Sept. 30. Two appropriation bills have been signed into law. Conference reports have been filed on two others. Final versions of the remaining nine are being worked on by House-Senate conference committees and likely will be completed well before Oct. 1. Research budgets, so far, are holding up quite well in a year when there wasn't supposed to be much room for increased funding.

The bill that has been signed into law is H.R. 4567, the Energy and Water Development Appropriation Bill, 1989, which funds almost all of the Department of Energy's research programs. The two exceptions are the fossil and conservation R&D programs, which are funded under H.R. 4867, the Department of Interior and Related Agencies bill that has been cleared by a conference committee.

Taken together, the two bills provide $4.8 billion for DOE R&D programs in fiscal 1989. That is an increase of just 5% over current funding levels and the lowest R&D increase allowed by Congress to date. And not all of DOE's research programs are getting even that much of an increase. For example, funding for basic energy sciences is set at $552 million, a decrease of 2% from the current funding level. Within that category the budget for operating expenses for the chemical science program is set at $135 million, up 3%, and that for materials sciences at $181 million, up 5%.

In contrast to the fiscal 1988 appropriation, which funded 10 specific university research projects out of the basic energy sciences budget, this year's bill specifies funding for only four projects: $13 million for the Center for Advanced Microstructure & Devices, Louisiana State University; $11.1 million for Loma Linda Medical Center in California; $10 million for the Barry Goldwater Center for Sciences & Engineering, Arizona State University; and $5.5 million for the Center for Automated Technology at Drexel University.

Congress provided only $100 million of the $316 million the Administration requested for the Superconducting Super Collider. Of the funds it did provide, $16 million is allocated for capital equipment needed to support the R&D effort and $84 million is for operating expenses, R&D, preliminary engineering and design, and site selection activities. Construction work is specifically prohibited.

Congress increased funding for DOE's university research support programs 38% to $22 million. However, it earmarked $6 million, or over 25%, of the money for university nuclear engineering programs and held funding for university research instrumentation grants constant at $5 million.

The other bill that has been signed is H.R. 4800, Department of Housing & Urban Development—Independent Agencies Appropriation Bill, 1989. That bill provides funding for, among others, the National Aeronautics & Space Administration, the National Science Foundation, and the Environmental Protection Agency.

NASA is undoubtedly the big winner in this bill. Its overall budget is up 21% to $10.7 billion, and its research budget is up 28% to $4.2 billion. The bill provides the full $900 million requested by the Administration for the space station. However, only half of that funding will be available for the agency to spend on Oct. 1. The rest will become available on May 15, 1989, unless the new President notifies Congress by Feb. 1 that he doesn't want any more money spent on the space station.

In addition, the NASA Administrator is given authority to transfer up to $30 million from the $290 million facilities account to the research budget. Of that amount, $10 million is to be spent on planetary programs and up to $10 million on the "scatterometer" instrument. Congress itself transferred $15 million from the facilities account into a "Science, Space & Technology Education Trust Fund." The money is to be invested in U.S. Treasury special issue securities, and the interest will be used to fund education improvement grants.

NSF did not fare so well as NASA. Still, its overall budget is up 10% to $1.9 billion, with funding for research and related activities up 9% to $1.6 billion. The conferees directed that the $20 million reduction from the budget request be applied equally across all disciplines except for ocean sciences and astronomical sciences, which are to receive the requested amount. In addition, the conferees expect NSF to provide the full $54 million requested for the five national supercomputing centers; to provide $1.5 million for computing capabilities

not available at those centers; to spend up to $3 million to support enhanced research efforts in ocean engineering; and to provide $900,000 to the International Institute for Applied Systems Analysis and $200,000 for the Cajun Pass drilling project.

Congress did not approve NSF's five-year, $150 million request for a new science and technology centers program, though it did not prohibit funding the centers out of existing funds. No such awards are to be made, however, until Congress approves NSF's fiscal 1989 operating plan. Funding for science education is up 23% to $171 million, with a minimum of $1 million to be used to support curriculum development programs for elementary and junior high schools. The conferees also accepted a Senate provision limiting the pay of principal investigators and others supported by NSF funds to $95,000 per year. The Senate report on the bill noted that some individuals were being paid as much as $135,000 a year.

For EPA, its intra- and extramural research budget is up 8% to just under $380 million. It includes $2 million to be matched on a 50-50 basis by private contributions for asbestos research; $2.6 million for research on waste minimization and pollution prevention; $500,000 for a cumulus clouds acid rain study at the University of North Dakota; and $450,000 for completion of the Kanawha Valley, W.Va., health effects study.

One of the first items of business when Congress returns this week from the August recess will be approval of the conference report on H.R. 4783, Departments of Labor, Health & Human Services, and Education, and Related Agencies Appropriations Bill, 1989. Congress has approved a 6%, $840 million increase to $7 billion for the National Institutes of Health. That amount includes a 30%, $39 million increase to $607 million for acquired immune deficiency syndrome (AIDS) research.

The budget for the National Institute of General Medical Sciences includes funding for the establishment of a new biotechnology-based research training program focused on the applications of engineering, physics, chemistry, mathematics, and biology to the interdisciplinary research needs of the emerging U.S. biotechnology industry. The NIH director's budget includes $14 million for research centers in minority institutions and money to support an additional 200 positions for AIDS research and an additional 150 positions for non-AIDS activities. And when President Reagan signs the legislation setting up a new Institute on Deafness & Other Communication Disorders, it will start out with a $96.1 million budget. The money will come out of funding approved for the current National Institute of Neurological & Communicative Disorders & Stroke, whose name will then be changed to the National Institute of Neurological Disorders & Stroke. □

Congress is fairly generous in setting 1989 R&D budgets

$ Millions	1989 Congressional appropriation	1989 Administration request	1988 appropriation	% change: Appropriation vs. request	% change: Appropriation vs. 1988
NASA	**$10,701.0**	**$11,488.0**	**$ 8,856.5**	**−7%**	**21%**
Space flight, control, and data communication	4,364.2	4,841.2	3,908.3	−10	12
R&D	4,191.7	4,446.7	3,274.2	−6	28
Research & program management	1,855.0	1,915.0	1,495.7	−3	24
Facilities	290.1	285.1	178.3	2	63
NIH	**7,158.9**	**7,123.2**	**6,766.6**	**7**	**6**
National Institutes	**6,570.9**	**6,588.5**	**6,181.8**	**0**	**6**
Cancer	1,574.4	1,593.5	1,469.3	−1	7
Heart, Lung & Blood	1,046.6	1,054.5	965.5	−1	8
Allergy & Infectious Diseases	745.0	745.4	638.8	0	17
General Medical Sciences	682.4	687.8	632.7	−1	8
Neurological & Communicative Disorders & Stroke	567.1	571.0	534.7	−1	6
Diabetes, Digestive & Kidney Diseases	560.4	565.9	534.7	−1	5
Child Health & Human Development	426.2	418.4	396.8	2	7
Eye	231.4	234.0	324.9	−1	3
Environmental Health Sciences	223.5	223.2	215.7	0	4
Aging	222.9	205.2	194.7	9	14
Arthritis & Musculoskeletal & Skin Diseases	160.0	158.9	147.7	1	8
Dental Research	131.0	130.7	126.3	0	4
Research Resources	**358.6**	**358.0**	**368.1**	**6**	**−3**
Other	**229.4**	**176.4**	**216.7**	**30**	**6**
ENERGY R&D	**4,800.6**	**4,721.8**	**4,576.8**	**2**	**5**
Weapons R&D, testing	1,487.0	1,465.5	1,466.9	1	1
General science and research	922.0	1,197.1	810.4	−23	14
Supporting research and technical analysis	642.2	611.8	648.5	5	−1
Nuclear	352.7	351.9	347.0	0	2
Fossil R&D	380.6	167.0	327.0	127	16
Fusion	351.5	360.0	335.0	−2	5
Environmental, biological activities	350.0	359.0	338.2	−3	3
Renewable energy source	148.9	123.2	147.6	20	1
Conservation R&D	165.7	86.3	156.2	92	6
NSF	**1,885.0**	**2,050.0**	**1,717.0**	**−8**	**10**
Research and related activities	1,583.0	1,603.0	1,453.0	−1	9
Science education	171.0	156.0	139.2	10	23
Antarctic program	131.0	141.0	124.8	−7	5
Science and technology centers	0	150.0	0	—	—
EPA R&D	**378.9**	**374.8**	**352.2**	**1**	**8**
TOTAL	**$24,924.4**	**$25,757.8**	**$22,269.1**	**−3%**	**12%**

Note: All numbers are estimates. **Source:** Congressional reports